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Safety Committee
Bulletin No. SM-1
Revision No. 2

SECRET

SAFETY COMMITTEE REGULATIONS FOR HANDLING C-616

INTRODUCTION:

This bulletin is intended to familiarize those persons handling C-616 with the hazards of the material and to advise safe handling procedures for the protection of themselves and fellow workers.

C-616 is a white solid which vaporizes at room temperature, and in contact with air it gives off dense white fumes which contain HF and a toxic dust, TO_2F_2. HF is corrosive, and its hazards are discussed in Safety Committee Bulletin SM-3. TO_2F_2 is a material of marked degree of toxicity to inhalation, and must be guarded against. Its hazards and methods of safe handling are discussed in Supplement 1 to Safety Committee Bulletin SM-1, Revision 1.

A. HAZARDS

(1) Sufficient information is at hand to know that all bodily contact with, or the inhalation of, the solid or vapor should be avoided. When C-616 reacts with human skin, burns occur which appear to be of a combination type caused by heat and chemical reaction. These burns are not as severe as those caused by HF.

(2) Inhalation of C-616 causes marked irritation of the upper respiratory tract. In high concentrations, it is irrespirable. In case of panic, several breaths may be taken, resulting in pulmonary irritation; fortunately, this irritation usually occurs high in the

respiratory tract and, in all but extremely high exposures, prevents high concentrations from being breathed into the lungs. No cases of more than transitory irritation of the bronchi have been observed, and none is anticipated unless a workman becomes trapped or is injured in such a way that he cannot leave the area.

Inhalation of concentrations which are either not irritating or are tolerable may produce other untoward effects; euphoria, drowsiness, lassitude, and nausea and vomiting. Chronic inhalation of an excessive amount may produce irritation of the kidneys, as evidenced by the appearance of albumin in the urine. Inasmuch as C-616 breaks down to a very toxic compound, TO_2F_2 in air, a part of the body damage must be attributed to this substance.

Untoward effects may be prevented entirely by keeping the atmospheric concentration at a safe level and the use of protective equipment described below under "C", in emergencies.

(3) Product C-616 is reactive with organic materials and mercury.

B. SHIPMENT AND RECEIVING

Product C-616 is shipped in clean, dry, nickel cylinders, of approximately 60# and 125# water capacity, by government trucks; the contents weigh approximately 150# and 350# respectively. (Some C-616 has been shipped in similar containers of 8, 12, and 18# water capacity).

Upon arriving at the plant, the cylinder should be handled by experienced men only who should reject any cylinder obviously defective or not properly identified. Cylinders should be weighed

and permitted to go into storage only if the content is within the safe limit, (3.08 x water capacity by weight).

Cylinders, covered with caps provided therewith, should be stored out of doors until ready for use. Alternatively, a detached brick or fireproof building or a fireproof room may be used where storage is preferred indoors. In case of storage inside of the building, ventilation must be provided by an air exhaust system with the duct opening located near the floor. The capacity of this ventilating system should be sufficient to provide ten air changes in the room every hour. The mechanical ventilation shall be in operation before anyone may enter the storage area.

Bulk storage of more than one tank or cylinder of C-616 should be either out of doors or in a fire resistant building. Storage yards and/or storage buildings shall be restricted areas and shall be detached from other buildings. Storage buildings shall have good natural ventilation, and shall have mechanical ventilation of sufficient capacity to change the air ten times per hour. The mechanical ventilation shall be in operation before anyone may enter the storage building.

When shipping cylinders are empty, they should be blown with nitrogen, and the nitrogen C-616 passed through an activated charcoal absorption system. The activated charcoal, when spent, is put into containers and put aside for shipping instructions. Empty containers with valves closed and covered with caps are to be returned without delay to the shipper.

C. PRECAUTIONS AND SAFETY MEASURES

(1) Only thoroughly trained and fully competent personnel

should handle C-616. These persons should be familiar with the safe methods of handling and should be checked frequently to make certain that safe methods are employed.

(2) Periodic examinations should be made by a physician familiar with the characteristics of C-616 on all persons who may come into more than casual contact with this product. Instructions for the physician will be furnished by the District Medical Section. Acute exposure should be immediately seen by the project physician.

Any person engaged in transferring C-616 from shipping containers to dispensing cylinders must be fully protected by adequate clothing, shields, and masks. The clothing shall consist of an inner and outer garment. The inner garment should be snug-fitting about the neck, wrists, and ankles. The outer one, preferably of the cover-all type, should be of a close weave cloth, fit snugly about the neck, and extend to wrists and over the shoes. Wrist and ankle straps are desirable. The insertion of trouser legs into tightly laced high top shoes forms efficient protection.

(3) An alarm system is recommended wherever considered necessary by the safety section having jurisdiction, to be sounded in case of serious leaks or breaks in C-616 systems. Operators should be thoroughly familiar with the alarm system, and should test it at the beginning of each work shift.

(4) All lines and systems should be thoroughly clean and dry before introducing C-616.

(5) All systems and containers should be tested for leaks and be made vacuum tight to 1 micron/hr. before use.

(6) Inasmuch as C-616 is one of the more toxic T compounds, in handling C-616 there should be adequate ventilation to keep the concentration below 20 micrograms per cubic meter to prevent symptoms due to chronic exposure.

(7) (a) Regular type production (150# water capacity) C-616 cylinders have a working gage pressure of 150#/sq. in. They are filled by the producers of C-616 with a maximum of 462# of C-616 (3.08 x the water capacity by weight.)

(b) Cylinders containing C-616 should never be heated above 212°F.

(c) Regular production type C-616 cylinders have a valve at both ends. The iron protection skirt on one end of the cylinder is longer than on the other. The cylinder number is stamped on the cylinder and inside the longer skirt. This end of the cylinder contains a plain valve and this is the valve which should be used to remove the contents of the cylinder in the gas phase. The valve on the opposite end (the valve protected by the shorter skirt), is attached to a dip pipe. This valve is used in emptying liquid from the cylinder when the cylinder is in a horizontal position. This valve should not be used in discharging the C-616 as a gas.

(d) Small cylinders for use in laboratory work should never be filled with C-616 in excess of 3.08 times the water weight capacity. The cylinders must be carefully checked and weighed before any connections are made to the apparatus. They should be rigidly secured before making connections or before heating to discharge contents.

(e) Any containers of C-616 used at elevated temperatures or pressures should be placed behind brick or sheet metal barriers so as to make it impossible for the contents to spray the operator in the event of a container failure.

(f) When circumstances prohibit carrying out item (f), the operator handling containers at elevated temperatures or pressures shall wear a hood, gloves, and either an air supplied, oxygen, or Army assault type mask.

Cylinders containing C-616 should never be heated with free flame.

(8) If serious leakage or breakage occurs:

(a) Leave affected area and sound alarm, if any.

(b) Close off the area and start the exhaust fan.

(c) When necessary to reenter to make emergency repairs or to rescue employees, wear hood and gloves and protective clothing and oxygen breathing apparatus or Army assault type masks. Another person similarly equipped shall stand by. Unprotected personnel may reenter only after the room has been declared clear and safe by the supervisor in charge.

(9) In areas where C-616 is handled extensively and minor leaks are frequent and serious leaks possible, equipment and floors should be of a nature not harmed by water, and hoses should be provided as necessary so the entire exposed area may be flushed with an excess of water.

Where water cannot be used for cleaning, the contaminated surfaces should be thoroughly brushed, wiped or vacuum cleaned.

(10) When C-616 comes in contact with the skin, IMMEDIATE treatment is necessary if severe burns are to be avoided.

(a) Flush the skin with copious quantities of tap water. (An emergency drenching shower equipped with a quick acting valve is recommended in case large quantities are spilled on the unprotected body.)

(b) Remove contaminated clothing.

(c) Continue flushing of the skin with tap water for at least 15 minutes.

(d) Soak injured area in 25% magnesium sulfate solution, or place compresses of 25% magnesium sulfate over the injured area and keep it moist. Never rupture vesicles or blisters that have formed. This reduces incidence of secondary infection.

An alternative is the application of the special magnesium paste available from the Karel First-Aid Co., 4342 West Ogden Avenue, Chicago, Illinois.

(e) Avoid all greasy ointments

(f) Obtain the services of a physician familiar with

HF burns. There should be available in the first-aid room, for the physician's use only, a hypodermic syringe and ampoules of sterile 10% calcium gluconate solution. Current observations indicate that even in severe burns the subcutaneous gluconate injection is rarely needed.

(g) It is imperative that even very small burns be reported and that treatment be given.

(11) In event of a severe acute exposure, damage to the lungs may occur. This is usually associated with shortness of breath and some respiratory difficulty. Signs, on examination of the chest, are those of early pulmonary edema, i.e., the presence of wet rales over lung fields. These patients should be kept quiet, warm, and treated symptomatically. Oxygen may be necessary in treatment. The use of positive pressure oxygen therapy may be necessary in very severe cases.

(12) When burns of the eye occur, the eye should be washed immediately with copious quantities of tap water and medical treatment sought at once. An upended faucet, or a drinking fountain may be used as emergency eye bath, or, if these are not available, water may be poured gently into the victim's eyes from a bottle or cup. Later, the eye should be washed for fifteen minutes with a 3% solution of boric acid. Subsequent treatment should be directed by an ophthalmologist.

(13) All persons handling C-616 should have a change of coveralls each week, and, if exposed, the individual must take a shower and change to fresh coveralls.

(14) In areas of maximum exposure a shower must be taken at the end of each day's work. However, in the case of laboratory technicians handling quantities of C-616 not in excess of 100 grams/day, it is necessary only to wash hands before eating and before leaving the premises for the day.

(15) Eating in workrooms is prohibited. It is advised that chewing gum, chewing tobacco, and candy be kept in uncontaminated areas.

(16) When removing protective clothing, the following procedure must be followed: Wash gloves, aprons, and boots with gloves still on the hands. Before removing gloves, remove face mask and wash in water. Take off apron, boots and gloves, and wash hands thoroughly in clean water. Store equipment carefully in a safe, accessible place.

(17) All protective clothing should be inspected by the local safety committee before its re-use. Any damaged protective clothing should be repaired before re-use, or discarded.

(18) Protective creams, if used, must be those recommended by the Medical Section of the U.S.E.D.

(19) Cleaning of floors is done preferably by washing them with copious quantities of water, and, where this is not practical, vacuum sweeping may be substituted.

SAFETY COMMITTEE

J. E. Curran

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R. Rosen, Chairman

Lt. J. W. Howland
Medical Liaison Officer

SECRET MEMORANDUM SECRET (COPY)

TO: LT. COL. J. R. RUHOFF

FROM: MR. R. C. McHARNESS

January 19, 1944

Handling of C-216

A. Hazards

The hazards involved in the handling of C-216 are due both to its extreme chemical reactivity and to its toxicity. C-216 is the strongest oxidizing agent known and will cause extremely painful burns. It will combine with practically all organic compounds as well as many inorganic compounds with explosive violence. Some metals, particularly steel, will burn in an atmosphere of C-216 if heated to their kindling temperatures.

C-216 and at least one of its reaction products (OF_2) have been reported to have a toxicity of the same order as that of phosgene.

B. Precautions

Because of its toxicity, C-216 should not be inhaled, even in very dilute concentrations. An adequate ventilation system should be provide and kept in operation at all times in order to maintain the C-216 concentration in the air at a minimum. Never attempt to work in a section in which there is any appreciable concentration of C-216 or its reaction products. When the concentration is very low, as indicated by the odor, work may be carried on for limited periods of time if a supply of pure air is assured the operator by requiring him to use an air mask. These masks should be washed, disinfected, and inspected before reuse.

No material is known that will furnish complete protection from high concentrations of C-216. Both rubber and asbestos will ignite when brought in contact with moderate concentrations of the gas. However, heavy rubber gloves should be worn at all times because they do prevent immediate contact with C-216, and are adequate protection from low concentrations of the gas for short periods of time.

All equipment should be dry and free of organic material before introducing C-216 into it. Equipment containing C-216 should be swept with dry air or nitrogen before working on it. This will minimize but not necessarily eliminate the hazard, particularly if valves are depended upon to isolate the system. Considerable trouble has been encountered with leakage in valves handling C-216, due to corrosion and to partial plugging with foreign material.

All handling of C-216 under pressure should be carried out from behind a brick or concrete barricade. Ventilation should be provided on both

sides of the safety wall. The system of valves and piping should be such that the pressure can be vented and the equipment swept with nitrogen before going behind the barricade. Asbestos gloves should be worn over the rubber gloves for added protection.

Cylinders of C-216 under pressure should be handled in such a manner that it will be impossible in case of a leak or accident for the stream of gas to be directed on the operator.

Since C-216 almost always contains some HF, the precautions applying to the latter (see memorandum on "Handling of Hydrofluoric Acid") should always be observed. These are in addition to those listed above.

C. First Aid

Since the reaction of C-216 with flesh is so rapid and its principal reaction product is HF, the first aid treatment is the same as that for HF as given in the memorandum on "Handling of Hydrofluoric Acid".

RCM-mfh
Jackson Laboratory

Supplement #1 to
Safety Committee
Bulletin No. SM-1

Revision No. 1

SECRET

MEDICAL CONSIDERATIONS OF WORK WITH C-616

A. Physical Properties of C-616

When C-616 reacts with the moisture of the atmosphere, HF is liberated, usually in the form of a white cloud, and a dust of TO_2F_2 of very fine particle size results.

When C-616 is absorbed into charcoal, it is changed largely to TF_4 which is relatively insoluble.

B. The Toxicity of C-616, TO_2F_2, and TF_4

When the amount of C-616 liberated into a room is sufficiently large, irritation of the skin and the mucous membrane of the eyes, nose and throat is noted. This irritation results not only from the HF formed, but also from the corrosive properties of TO_2F_2. Low concentrations of C-616 in the atmosphere, like HF, are annoying from the standpoint of irritation. Serious irritation from high concentrations is unlikely to occur, because the irritation of the upper respiratory tract compels the individual to leave the effected area. HF in the atmosphere can be tolerated chronically in concentrations up to 10 p.p.m. When the concentration exceeds 10 p.p.m. very much, the air becomes irrespirable.

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The use of C-616, TO_2F_2 and TF_4 in industry presents two other possible hazards. First, the chemical toxicity of the materials, and second, possible harmful effects from their natural radioactivity. IT SHOULD BE NOTED THAT, TO DATE, NO TOXIC EFFECTS OF EITHER TYPE HAVE BEEN OBSERVED.

1. Chemical Toxicity

The possibility of chemical toxic effects developing depends upon the relative ease with which the substances in question are absorbed by the human body by different routes of absorption, i.e. from the respiratory tract, the gastro-intestinal tract and the skin. Ease of absorption by any route depends upon the degree of solubility of the compounds in body fluids. Fortunately, TF_4 has a very low solubility in water and a limited degree of solubility in dilute HCl. On the other hand TO_2F_2 is highly soluble in both water and dilute HCl.

a. Chemical Toxicity in Experimental Animals

The intraperitoneal injection of water-soluble T material in dogs or rats is followed by acute poisoning, characterized by severe kidney damage affecting chiefly the convoluted tubules, and by the appearance in the urine of numerous hyaline and granular casts. Glycosuria may be present and occasional red blood cells may be found. The presence

of acetone bodies and other organic acids indicates the production of acidosis. Liver damage plays a secondary role and the principal cause of acute poisoning must be attributed to renal damage. The acutely toxic dose of soluble T material by injection is of the same order of magnitude as that for mercury bichloride and arsenic trioxide.

Recent experiments have shown that considerable amounts of insoluble T material, incorporated into the diet of rats and mice are tolerated for fairly long periods without the appearance of striking toxic symptoms. However, smaller amounts of water-soluble T compounds cause a retardation of growth rate of young animals. Furthermore suggestive evidence of storage of T compounds in the bones was obtained upon long-continued administration of such compounds to animals.

There is no evidence at present that either TF_4 or TO_2F_2 can be absorbed through the unbroken skin.

Experiments on various species of animals indicate that long-continued inhalation of heavy concentrations of T compounds as dusts is followed by chemical toxic effects.

b. Chemical Toxicity for Humans

Acute chemical poisoning from T materials has not been encountered in industrial workers. However,

effective safeguards should be taken to prevent the occurrence of chronic poisoning from long-continued exposure of workers to dusts containing T material. The concentration of such dusts in factory air should be kept at a minimum (<150 micrograms/cu. meter) and,where dusts cannot be controlled adequately by ventilation or other procedures, the use of efficient respirators is imperative. No final limit for the dust content has been set, but it has been considered advisable to handle this material as carefully as lead, and, therefore, to keep the concentration in air below 150 micrograms per cubic meter (the limit allowed for chronic exposure to lead.) In areas in which C-616 is handled in small quantities, in closed systems, or under vacuum, it is considered extremely unlikely that toxic effects will be encountered even if occasional mechanical failures allow the material to escape into the atmosphere.

In any event, careful safeguards should be taken to reduce exposure of workers to dust as far as possible, in order to avoid the possibility of absorption of T material by lung, the gastro-intestinal tract or the skin. Additional preventative measures are: precautions to avoid entrance into the mouth of contaminated food, chewing tobacco, etc; cleanliness

of skin by thorough washing and frequent changes of clothing; treatment of contaminated wounds by thorough washing with a 5% solution of carbonate of soda (solvent for many T compounds) followed by the wearing of a water-tight dressing or shift to other work until the wound is healed.

Because of the insidious nature of the chronic chemical poisoning by T compounds, the existence of such poisoning may not be detected easily in the early stages. The appearance of albuminuria in excess of 0.1% and renal casts in a previously normal urine should be regarded as danger signals and the worker shifted to other work and kept under observation by the plant physician until the urine is normal again.

2. Natural Radioactivity of T Material

The radioactivity of T material is similar to that of radium. The emitted particles are of the same type as those emitted by radium, but there are fewer particles per unit of time and the particles are of different energies. The particles which are emitted by the natural decay of T material include alpha particles, beta particles and small amounts of gamma rays. The energy radiated by the disintegration of 1 microgram of radium will be matched by the disintegration of 3-5 grams of T.

a. Alpha Particle Radiation

The alpha particles have a very low penetrating power and are completely absorbed by less than 0.1 mm of tissue. For all practical purposes alpha particles arising from an external source may be disregarded. If the particles arise from radioactive material introduced into the tissues, the consequences may be more serious since the ionization along the path of the particle is very intense.

b. Beta Particle Radiation

Beta particles from T material are more penetrating than alpha particles but are absorbed in the first 2 or 3 mm of tissue. Measurements have indicated that the beta radiation from the surface of T material is 0.25 r per hour when the material is in direct contact with the skin. It has been suggested by the Medical Section of the Manhattan District that the maximum daily exposure to the hands be set above the tolerance for total body radiation. The limits were determined to be 0.5 r per day of beta radiation to the hands although, for a limited period, it is not unlikely that even more radiation might be given to the hands without deleterious effect. It is recommended, however, that all reasonable precautions be taken to reduce the beta radiation to a minimum.

c. Effects of the Natural Radioactivity on the Skin

The beta ray activity of T material conceivably might cause damage to the skin of the hands. The alpha ray activity may be ignored since it cannot penetrate the superficial layers of the skin.

Damage to the skin may first be observed in the ridges of the finger-tips, and the skin about the nail beds. The skin first becomes dry because of the effects upon the glands in the skin. Eventually the skin becomes brittle and cracked. The nails may be ridged longitudinally, and crack easily.

d. Measures to Protect the Skin

In handling dry compounds of T material, it has been recommended that canvas gloves be worn and that a clean pair be used daily.

e. Systemic Effects from Natural Radioactivity

The appearance of systemic effects due to the natural activity of T is not anticipated. If T compound were stored in the body in a similar manner to the storage of radium, it would require several million times as much T compound to produce the biological effects encountered with radium poisoning. This is deduced from a comparison of the rates of disintegration of the two elements, and an estimate of the energy of the emitted particles in the decay

chain.

Systemic effects, from the natural radioactivity of T, would first be manifested by slowly progressive hematologic disturbances. These hematologic changes would involve an anemia, (diminished amount of hemoglobin or reduction in the number of red blood cells) of varying degree, or leukopenia (a reduction in the white blood cell count.) Occasionally a relative lymphocytosis (an increase in the proportion and number of lymphocytes in the circulating blood) may be the earliest indication.

C. Recommendations for Safe Handling

1. In any operation which produces dust of T material a respirator safe against toxic dust should be worn. The Comfo respirator BM 2101 with the all dust filter BM 2133 has been tested and found to be satisfactory. The Clearvue Dustfoe respirator BM 2147 with all dust filter BM 2148 is also satisfactory but somewhat less efficient.

2. If C-616 escapes into a room, workmen shall leave the area until the material has been evacuated, or be provided with a gas mask having a cannister safe for acid gases equipped with a dust filter, or preferably an air-supplied unit.

3. If burns occur from C-616 they should be treated in the manner recommended for HF burns.

4. Fume exposures to C-616 should also be treated as exposures to HF.

D. Recommendations Concerning Personal Hygiene

1. Each employee who gets either C-616 or its hydrolysis products on his skin shall be required to wash his hands and face thoroughly before eating.

2. Each employee whose skin becomes contaminated with the material shall be required to take a shower before leaving work each day.

3. Washing before meals and taking of showers will be supervised.

4. Washing of hands will be done with soap and water and a brush. Care will be taken to remove the material deposited under the nails.

5. It is recommended that the use of vanishing creams or of active wetting agents be prohibited in the clean-up process.

6. Street clothing will not be worn at work in any operation involving contact with T material; likewise work clothing will not be worn away from work.

7. Each employee will wear a clean suit of work clothes each week. He will change at more frequent intervals if his clothing becomes excessively soiled or if it becomes soaked with wet T materials.

8. Eating in work rooms will be forbidden.

9. If the employee uses chewing tobacco, adequate precautions will be taken to prevent the tobacco from becoming contaminated in the package, and to prevent transfer of T material from soiled hands to his mouth. The same precautions also apply to the use of chewing gum.

SAFETY COMMITTEE

D. J. McKinzie

L. Van Orden

R. Rosen, Chairman

Capt. John L. Ferry
Medical Liaison Officer

Safety Committee
Bulletin No. SM-3

SAFETY COMMITTEE REGULATIONS FOR HANDLING HYDROFLUORIC ACID IN LABORATORIES AND FOR SMALL SCALE OPERATIONS

A. Hazards

(1) The principal hazard from the use of hydrofluoric acid is the marked corrosive effect which the acid has on tissue. If the HF is not removed after it comes into contact with the skin, it tends to keep penetrating with the production of a deep, slow-healing painful ulceration.

(2) Local irritation of the mucous membrane of the eyes, nose, mouth and throat will occur if the vapor of hydrofluoric acid is deposited upon them. This irritation fortunately occurs even with fairly low concentrations, and concentrations which are sufficient to cause serious damage to the lungs cannot be breathed. Fatalities have been reported only in cases in which injury or unconsciousness prevented the exposed person from leaving the area.

(3) Even low concentrations of hydrofluoric acid (5-10%) are capable of producing serious burns. In this dilution the appearance of pain may be delayed for several hours, and before it appears deep penetration of the tissues may have occurred.

(4) In concentrations which can be tolerated chronically there is almost no possibility of producing systemic effects.

(5) The following concentrations have been set tentatively as the safe limits for the designated exposures:

a. 6 ppm. for chronic exposure

b. 10 ppm. maximum concentration allowed for exposures up to 30 min.

c. 50 ppm. dangerous even for a short time.

B. Shipment and Storage

(1) Rubber drums (ICC-43A) are the usual means of shipping 100 pound lots of acid at strength of 30%, 48% and 60%. They are treated with either an inner ply of paraffic-impregnated rubber, or are lined with neoprene. The venting of rubber drums is not essential as the end of the drum acts as a diaphragm.

(2) Lead carboys (ICC-1B) enclosed in a wooden box are also used for 100 pound lots and lead jugs (ICC-1B) are used for 10 and 20 pound lots of acid at strengths of 30%, 48% and 60%. Upon receipt of a lead carboy, it should be vented by carefully removing the large stopper. (See C-3.)

(3) Passified steel drums (ICC spec. 5A) are sometimes used for shipping 60% and 80% acid in lots of 165 pounds and 1000 pounds. These drums should be laid on their sides with the filling bungs up and should be vented at weekly intervals. The storage period should not be extended

beyond four months since local corrosion may take place, which will result in leaks. Do not add water to steel drums for this disturbs the passification.

(4) Anhydrous acid is shipped in ICC-4B cylinders in 6 pound, 105 pound and 205 pound lots. Cylinders should be weighed and tagged before use.

(5) Anhydrous HF is also shipped in tank cars. The recommended practice for unloading tank cars is described in MCA Manual Sheet TC-5. (These have been ordered and will be sent separately.)

(6) Hydrofluoric acid containers may be stored outdoors but not directly on the ground providing they are suitably sheltered from the direct rays of the sun. Containers may be stored indoors in a cool place provided with ventilation capable of producing an air change each two minutes. Container must not be stored in the proximity of steam lines or radiators.

(7) Complete information on the recommended practice for the safe handling and discharging of containers appears in MCA Manual Sheet H-1. (These have been ordered and will be sent separately.)

C. Operation

(1) Persons handling hydrofluoric acid should be equipped with protective clothing described under E-10.

(2) When moving drums or carboys from storage areas to work areas, only three or four-wheeled flat trucks or a rubber-tired acid carboy truck should be used. Large cylinders should be transported by a cylinder truck.

(3) When opening an hydrofluoric acid container, the bung should be removed very slowly with a long-handled pipe wrench. When the sound of escaping gas is heard, the operation should be stopped until the internal pressure on the drum has been relieved.

(4) Rubber drums, lead carboys and passified steel drums should be emptied by means of a neoprene tube or lead tube siphon. This siphon must be started by means of a hand pressure bulb.

(5) Lead gaskets on flanges should be replaced with new ones when connecting and disconnecting any flanged connection.

(6) Each operation in which hydrofluoric acid is involved should be carefully evaluated and specific operating instructions written in collaboration with local safety committee or safety engineer.

(7) After use, tools must be immersed in 15% sodium carbonate solution and then washed with tap water. All tools used in the operation must be kept in their proper places, and in first-class condition.

(8) Copper, nickel and stainless steel are recommended for use in fabrication of HF equipment. Monel and steel may be used but brass and cast iron are to be avoided. The last two mentioned are reactive with HF and serious corrosion difficulties will be encountered. If steel is used, extra heavy seamless pipe and forged steel valves and fittings are recommended.

(9) Equipment for handling liquid HF should be arranged so that it can be worked on from behind a barricade. Barricades must be used when feeding liquid HF to systems under pressure.

(10) If at all possible, equipment which has contained HF should be vented and washed with water before working on it. In cases where the equipment must be kept dry it should be swept out with dry air before working on it in order to reduce the hazard to a minimum.

D. Disposal

(1) When discarding contaminated or partially spent HF solutions, the solutions should be diluted with sufficient water so that the concentration of HF going through the drain is not in excess of 1%. Fresh water should be continued in the drain to assure complete flushing. If large amounts of HF solution are involved, provisions should be made to neutralize the HF solution with lime water down to tolerance permitted by local health authorities.

(2) The insides of empty shipping containers should not be washed. All such containers should merely be closed with the appropriate closure and reshipped to the manufacturer.

E. Precautions and Safety Measures

(1) If severe burns are to be prevented when HF is spilled on the skin, it is imperative that that treatment be

instituted immediately and that the contaminated skin be flushed with large quantities of water. This flushing should be continued for at least 15 minutes if the person is not burned so severely that he is in shock. An emergency shower equipped with a quick-acting valve should be located in close proximity to the HF work area. Contaminated clothing should be removed.

(2) Flushing with water may be alternated with immersion of the affected area in a magnesium oxide slurry.

(3) This procedure may be followed by soaking the burned area in an iced solution of 70% alcohol, or in a saturated solution of sodium bicarbonate.

(4) Following the flushing with water, or the soaks if the latter procedure is elected, a special magnesia ointment is rubbed into the burned area, and a dressing of the same ointment applied. (Special ointment for the treatment of HF burns may be obtained from the Karel First-Aid Supply Co., 4342 West Ogden Avenue, Chicago, Illinois, or from the Harshaw Chemical Co., Cleveland, Ohio.)

(5) The victim would then be examined by a physician experienced with this type of burn. Injection of (by the physician) 10% solution of calcium gluconate solution into, under and around the burn has been found to be very effective in preventing penetration of HF and in stopping the pain. It is imperative that even very small burns be reported and adequate treatment given.

(6) If hydrofluoric acid is splashed into the eyes, they should be thoroughly flushed with water, using an up-ended faucet, a drinking fountain, or where these are not available water may be gently poured into the patient's eyes from a cup or blow-bottle.

(7) After the eye has been flushed with water, the irrigation is continued with 3% solution of boric acid or sterile normal saline solution for 15 minutes or until the doctor arrives.

(8) Everyone handling HF should be educated as to the hazards and the necessity for prompt treatment.

(9) Where the acid is used in a process or where large quantities of the acid are required, local exhaust ventilation should be installed to draw off the harmful fumes down to tolerable limits. (See A-5.)

(10) Anyone entering area in which the acid is used should wear goggles or face shield.

(11) Operators working on HF equipment should always wear rubber* gloves.

(12) Inspectors, persons discharging HF or persons doing repair work on equipment in contact with HF should first put on personal protective equipment: splash-proof goggles, cellulose acetate face mask and head protector, rubber* apron, shoe protectors or rubber* boots, and rubber* gloves. Respirators should be worn. The employee should wear rubber* gloves with the gauntlets. The bottom of the apron should be below the

*Natural or synthetic

tops of the rubber* boots, if boots are worn. A thin film of vaseline applied to the goggles will lessen the damage that might be caused by the liquid or vapor touching them. In the event of a large leak or spillage, workman should use a rubber* suit in place of rubber* apron.

(13) When repairing or dismantling hydrofluoric acid systems, rubber* dipped canvas gloves should be worn over the usual rubber* gloves. The canvas gloves are essential to prevent rips or tears in the rubber* gloves.

(14) After the acid has been put away and all the handling equipment has been thoroughly washed with water, the protective equipment should be taken off according to the following procedure. Gloves should first be thoroughly washed with water while still on the hands, as should the apron and foot protectors or rubber* boots. The face mask should then be removed, while the gloves are still on the hands, and washed in water; and then the apron, foot protectors or rubber* boots and gloves may be taken off. The hands should then be thoroughly washed in clean water and the goggles taken off and washed. The equipment should then be carefully stored.

(15) Whenever acid has been removed from any type of drum and the opening has again been closed, the drum should be flushed off with water to protect persons who may handle the container later.

*Natural or synthetic

(16) Clothing on which the acid has been spilled should be removed and not again worn until it has been thoroughly washed. Before the clothing is washed, it should first be thoroughly soaked in water or sodium bicarbonate solution.

(17) Acid spilled on the floor should immediately be neutralized with soda ash and cleaned up to reduce the danger of burns to workmen wearing leather shoes.

(18) Porous materials that have come in contact with the acid should not be touched with the bare hands until they have been neutralized with soda ash. Even after neutralizing, it is advisable to wear rubber gloves when handling such articles. Many materials, such as rubber, are not particularly porous to acid below 40% but when in contact with 60% for a time may require soaking for a week to remove the HF.

(19) Lunches are not to be eaten in areas where hydrofluoric acid is used.

(20) All protective clothing must be examined by the local safety committee prior to reuse.

SAFETY COMMITTEE

D. J. McKinzie

L. Van Orden

R. Rosen, Chairman

Capt. John L. Ferry
Medical Liaison Officer

SECRET

SECRET MEMORANDUM SECRET (COPY)

January 19, 1944

TO: Lt. COL. J. R. RUHOFF

FROM: MR. R. C. McHARNESS

Handling of Hydrofluoric Acid (HF)

A. Handling of HF in the Laboratory and Semi-Works

Precautions to be Taken:

Hydrofluoric acid is a compound that causes severe burns which heal slowly. This is true not only of the liquid but also of the vapor and even of dilute solutions. Hence rubber gloves and protective goggles, or a face shield must be worn when handling HF in any form in open containers.

Since the boiling point of HF is below room temperature (19° C.), any closed container of HF must be considered to be under pressure and treated with extra care. When working with such containers the use of a face mask and rubber gloves is imperative. The use of a rubber hood in addition to the face mask is also necessary if large quantities of HF are being handled or if any difficulty is being experienced with the equipment. As an added precaution it is desirable to have equipment arranged so that it can be worked on from behind a barricade. This precaution is required when feeding liquid HF under pressure.

If at all possible, equipment which has contained HF should be vented and washed with water before working on it. In cases where the equipment must be kept dry it should be swept out with dry air before working on it in order to reduce the hazard to a minimum. Even after this treatment, goggles and rubber gloves must be worn, as dangerous quantities of HF may still be present particularly in gaskets and dead end spaces.

If HF is spilled on the floor or equipment it should be washed away with large amounts of water. Some materials such as rubber, wood, paint films and various types of gaskets and packing absorb HF quite readily. Such materials should be handled with rubber gloves even after thorough washing with water.

Cast iron must never be used in equipment handling HF.

If at all possible always work near a safety shower. If this is not possible then a pail of water or a running stream of water should be close at

In addition to the water, bottles of Ca (OH)2 (slaked lime) and MgO slurry should be nearby.

First Aid:

Once HF gets on the body its action is very rapid. Hence, speed is essential if first aid is to do the most possible good.

The first thing to do is to wash off the HF with large quantities of water. This should require not more than 10 to 15 seconds. Then bathe the injured portion with the Ca(OH)2 slurry. After 1 to 2 minutes wash off the Ca(OH)2 slurry completely and apply the MgO slurry liberally. Then report to the hospital for further treatment.

B. Handling of HF in the Plant

Hydrofluoric Acid Building:

1. Lunches are not to be eaten in this building.

2. Hydrofluoric acid is a compound that causes painful burns that heal slowly; even very dilute hydrofluoric acid will cause severe burns. Goggles must always be worn when working with equipment containing hydrofluoric acid. Neoprene gloves must be worn in the presence of anhydrous acid and rubber gloves in the presence of weaker acids. Wash gloves immediately at the conclusion of any work involving acid. All gloves are to inspected for any imperfections before they are used. Rubbers, rubber shoes, or boots must be worn when working with equipment containing hydrofluoric acid. When working in the presence of acid vapors a fume or gas mask should be worn. An HF ointment is also provided to be applied to the skin affording protection against acid vapor irritation.

3. Rubber gloves and goggles must be worn when handling sulfuric acid or when working on any equipment containing same.

4. If either sulfuric or hydrofluoric acid comes in contact with any part of the body, wash with excess water immediately and report to the plant hospital for further treatment.

5. Respirators must be worn when working in the presence of any sluorspar dust.

6. The HF plant sludge contains sulfuric and hydrofluoric acids and may be the cause of severe burns. When working with sludge, rubbers or pullover boots, goggles and rubber gloves must be worn.

7. Ammonia is a poisonous gas and excessively irritating. Wear a gas mask when it is necessary to work in ammonia fumes. Keep caps tightly screwed on cylinders except when using gas. Ammonia fumes, when mexed with air in certain proportions, are highly explosive, consequently an open flame must never be used on equipment containing ammonia.

8. Air and gas mask equipment must at all times be kept in condition for instant use. They must be cleaned and returned to their proper places immediately following use, and in the case of gas masks the canister card must be marked to show date, length of time used, and initials of user. Two hours is the maximum time a canister may be used.

9. All tools used in the operation must be kept in their proper places, and in first-class condition. Rope slings are not to be used in the area.

10. All exits and safety showers must be kept unobstructed and showers tested daily.

11. Only authorized persons are permitted to enter electric control rooms.

12. There is always a possibility that any water on the floor may contain quantities of hydrofluoric acid, consequently it must be considered and treated as weak hydrofluoric acid.

C. Safety Requirements for Mechanics Working on HF Equipment in Semi-Works Engineering Area

1. Only first class mechanics will be allowed to work on any equipment which has been subjected to HF. (This rule may be waived only by the General Foremen).

2. Acid protection must be worn as required by the Engineering Foremen or Area Engineers in accordance with the following type jobs:

A. Inspection of equipment and supervision of work.

1. Rubbers or rubber safety shoes and one pair of Neoprene gloves must be worn if there is any possibility of spills or if it is necessary to touch equipment.

B. Light work on any equipment, electric wiring, etc., whose outside surfaces may have been exposed to HF fumes or liquid.

1. Rubbers or rubber safety shoes and one pair of Neoprene gloves must be worn at all times.

6. Heavy work on any equipment, electric wiring, etc., whose outside surfaces may have been exposed to HF fumes or liquid.

1. Rubbers or rubber safety shoes and one pair of Neoprene covered by one pair of rubber dipped canvas gloves must be worn at all times. Note: (Canvas gloves are very necessary in order to prevent cutting and ripping of the Neoprene gloves).

D. Working on equipment, electric wiring, pipe lines, etc., whose outside surfaces have been exposed to HF fumes or vapor or when there is any possibility of HF vapor or fumes escaping.

1. One pair of Neoprene, one pair of canvas dipped gloves, boots, hood, and acid coat must be worn.

2. A combination hood and air mask shall be worn if work must be done while fumes are present.

3. Instructions as to the type of protective clothing to be worn on each specific job will be given by the Engineering Supervision only, never by the Operating Supervision. However, it will be the responsibility of the Engineering Supervision to determine all the operating details from the Operating Supervision before safety instructions are issued.

4. All operating equipment must be thoroughly cleaned of process material, washed or steamed, and approved by both the Operating and Engineering Supervision before any mechanical work is started.

5. Mechanics working in HF equipment are to secure Neoprene and rubber dipped gloves and overshoes from Area Tool Room.

6. Mechanics must periodically inspect gloves while working to determine whether gloves have been accidentally damaged.

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7. All protective clothing, tools, and the vicinity around which the job has been completed, must be thoroughly washed by the mechanic before he removes his protective clothing, or leaves the job.

8. In removing gloves, first loosen both gloves with the opposite gloved hand, and, secondly, shake gloves off hands. Never remove gloves with the bare hands. Goggles must be worn until gloves are removed.

9. All suspected contact of the body to process material should immediately be washed with an abundance of running water (and the mechanic should report immediately to the Medical Building). This quick action is necessary, since contact with the material may cause only a slight tingling sensation at first. If immediate care is not given, however, a serious burn can result. Should a person who has been exposed to hydrofluoric acid develop a severe pain in exposed member after leaving the Dye Works, immediately report to the Plant Medical Building so that treatment can be given.

10. Care of Rubber Gloves by Tool Room Attendant.

    1. Used gloves are taken by Tool Room attendant and immersed in "Coro-Nelium" (A disinfectant), then washed off in water, and placed on stand to dry. After drying, they are to be tested for holes by the Tool Room attendant and are to be sprinkled with talcum powder and stored in a dry place for future use.

       Note: Coro-Nelium concentration to be 1 oz. to 1 gal. of water. Coro-Nelium is a strong disinfectant, therefore, must be handled carefully, wearing gloves and goggles while using.

RCM-mfh
Jackson Laboratory

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